an organic solvent; dispersing by mixing the suspension in which the ultrafine ceramic oxide powder is dispersed with the ceramic sol solution; forming a piezoelectric/electrostrictive film element by submerging a substrate into the suspension which the ultrafine ceramic oxide powder and the ceramic sol solution are mixed and then by performing electrophoretic deposition; and thermally treating the piezoelectric/electrostrictive film element at 100-600°C , so that the solvent is removed by the thermal treatment and the bonding among the ultrafine ceramic oxide powder particles is induced while the ceramic sol acts as a reaction medium on the surfaces of the ceramic oxide particles.

Also the present invention features a piezoelectric/electrostrictive film element produced by a method comprising the steps of : preparing a solution or a dispersed mixture containing constituent ceramic elements by dissolving or dispersing the raw material of constituent ceramic elements in a solvent or dispersion medium; preparing a mixed solution by adding citric acid into the solution or the dispersed mixture in which the constituent ceramic elements are dissolved or dispersed; getting ultrafine ceramic oxide powder of particle size less than 1 μm with uniform particle diameter size distribution by forming ceramic oxide without scattering over, by nonexplosive oxidative-reductive combustion reaction by thermally treating the mixed solution at 100-500°C ; preparing a suspension by dispersing the ultrafine ceramic oxide powder in an organic dispersant; preparing ceramic sol solution by dissolving constituent ceramic elements of same or similar

constituent with the ultrafine ceramic oxide powder in water or an organic solvent; dispersing by mixing the suspension in which the ultrafine ceramic oxide powder is dispersed with the ceramic sol solution; forming a piezoelectric/electrostrictive film element by submerging a substrate into the suspension which the ultrafine ceramic oxide powder and the ceramic sol solution are mixed and then by performing electrophoretic deposition; and thermally treating the piezoelectric/electrostrictive film element at 100-600°C, so that the solvent is removed by the thermal treatment and the bonding among the ultrafine ceramic oxide powder particles is induced while the ceramic sol acts as a reaction medium on the surfaces of the ceramic oxide particles.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a flow diagram producing method of ultrafine ceramic oxide powder used in the present invention.

Figure 2 is a flow diagram of forming process of piezoelectric/electrostrictive film element using the conventional electrophoretic deposition.

Figure 3 is a flow diagram of a method for forming a piezoelectric/electrostrictive film element using the electrophoretic deposition at low temperature according to the present invention.

DETAIL DESCRIPTION

The present invention will be explained in detail.

First, a method for producing a ultrafine ceramic oxide powder used as a raw material in piezoelectric/electrostrictive film element producing according to the present invention as in

a flow diagram of Figure 1 will be explained.

A ultrafine ceramic oxide powder producing method of the present invention comprises the steps of: sufficiently dissolving or uniformly dispersing the raw material of constituent ceramic elements in solvent or dispersant to make a solution or a dispersion mixture containing the constituent ceramic elements; adding, into the solution or the dispersion mixture containing the constituent ceramic elements, citric acid in no less than the required amount to give rise to oxidative-reductive combustion reaction with an anion of the ceramic constituent ceramic element so as to make a mixed solution; and thermally treating the mixed liquid at 100-500°C. But it may additionally further comprises a step of conducting additional thermal treatment at 700-900°C to increase crystallinity.

As for the raw material containing the constituent ceramic elements, use is made of from among oxide, carbonate, nitrate etc. of constituent ceramic element, its salt with organics or inorganics, or constituent ceramic elements complex.

As for the constituent ceramic element, it is preferable to use a piezoelectric/electrostrictive ceramic element comprising lead (Pb) and titanium (Ti) as basic constituent elements.

Especially as for the constituent ceramic element, it is preferable to use that composed of elements including lead (Pb), zirconium (Zr) and titanium (Ti), or lead (Pb), zirconium (Zr), titanium (Ti) / lead (Pb), magnesium (Mg), niobium (Nb).

As for the solvent or the dispersant to dissolve or disperse the raw material of constituent ceramic elements, one